

PREDICTING AIR EXCHANGE RATES AND PARTICLE LOSSES INSIDE VEHICLES

Fruin Scott, *University of Southern California, USA*

Hudda Neelakshi, *University of Southern California, USA*

Kostenidou Evangelia, *University of Southern California, USA*

Delfino Ralph, *University of California - Irvine, USA*

Sioutas Constantinos, *University of Southern California, USA*

Background and Aims: Ultrafine particle (UFP) losses inside vehicles are strongly negatively correlated with air exchange rate (AER), but the literature only reports AER measurements for 16 vehicles total during real-world driving. UFP losses cannot be predicted without knowing AER, but AER is a complicated function of vehicle characteristics and speed. We used improved AER measurement methods to test a much larger, representative sample, from which we developed predictive models of AER and UFP losses.

Methods: A 60-vehicle sample was selected to be representative of the California fleet in terms of age, mileage, and model. We measured CO₂ build-up rates from vehicle occupants and then calculated AER from equilibrium CO₂ concentrations (where occupant CO₂ production balanced CO₂ removal rates due to AER). AER was then correlated with particle loss fractions for a subset of 90 AER measurements. Predictive models for both AER and particle loss fraction were developed.

Results: A predictive model for AER using only vehicle age, mileage, speed, and manufacturer (all easily ascertained information) could account for 70% of the variation in AER in the low AER recirculation (RC) conditions. Across all AER conditions (RC or outside air [OA]), nearly 90% of AER variation was explained. AERs ranged from ~0 to 145 hr⁻¹, and UFP losses correspondingly ranged from nearly 100% to 40%. Using only the ventilation setting (OA or RC), relative fan setting (for OA), speed (for RC), and vehicle age, 87% of the variability in particle loss was explained.

Conclusions: Our models successfully predict AER and expected UFP concentrations as functions of easily-obtained vehicle characteristics, thus are useful for epidemiological studies. Variables include occupant choice of ventilation setting (OA or RC), vehicle age and mileage, speed, and fan setting. These models will be used in an upcoming cohort of Los Angeles commuters to predict UFP exposure.